

REPUBLIC OF AZERBAIJAN

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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

**THE ROLE OF ECOLOGICAL FACTORS IN THE
DEVELOPMENT OF FISH IN NATURAL AND ARTIFICIAL
LAKES OF NAKHCHIVAN AUTONOMOUS REPUBLIC**

Speciality: 2401.01 – “Zoology”

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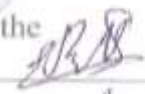
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INTRODUCTION

Relevance of the topic, degree of development: Fishing is one of the oldest activities of mankind to meet food needs. Throughout history, humans have always needed fish, so it has become an important link in the cultural food chain. For this reason, fishing activity is carried out by creating artificial systems and its importance is increasing day by day.

Starting from the 50s of the 20th century in our country, due to the construction of hydropower plants on the Kura and Araz rivers, the intensive development of agriculture and the expansion of irrigated cropland, as in other regions, in the territory of the Nakhchivan Autonomous Republic, in the territory of the Nakhchivan Autonomous Republic, the total area is about 20,000 hectares. water reservoirs (Nakhchivan, Arpachay, Vaikhir, Sirab, Uzunoba, Nehrem, Bananiyar, Dastagol, Batabat, etc.) were created. A new ecological environment for hydrofauna has been created in these reservoirs, where an additional resource source has been created to meet the population's demand for fish and fish products. The organization and efficient operation of fisheries in the newly created reservoirs, the detailed study of the ichthyofauna formed here, and conducting research to determine the role of ecological factors in the development of fish are of great importance.

Although studies related to ichthyological studies were previously conducted in the lakes of the autonomous republic, studies related to the role of environmental factors in the development of fishes distributed in these lakes have not been conducted in this direction.

One of the most urgent issues in modern times is the preparation of scientific bases required for the development of fisheries by determining the role of environmental factors in artificial and natural lakes of Nakhchivan Autonomous Republic.

The purpose and objectives of the research: Determining the modern aspect of the ichthyofauna of natural and artificial lakes of Nakhchivan Autonomous Republic, the role of environmental factors

in their development, preparing recommendations to reduce the negative impact of economic activity on the ichthyofauna of water bodies was the main goal of the research.

To achieve the intended goal, the following issues are planned to be studied:

1. Determining the modern species composition of ichthyofauna in natural and artificial lakes of the autonomous republic;
2. Monitoring changes in living conditions of fish species in sututars;
3. Study of the main environmental factors affecting the development of fish populations in natural and artificial wetlands;
4. To analyze the modern state of the ichthyofauna of the large reservoir, which plays an important role in providing fish products to the population of the Nakhchivan Autonomous Republic, to evaluate the fish stock and the factors influencing their development, to make recommendations on the efficient use of bioresources;
5. Prepare recommendations for optimizing the management of fish resources in natural and artificial fish ponds of the autonomous republic. Although studies related to ichthyological studies were previously conducted in the lakes of the autonomous republic, studies related to the role of environmental factors in the development of fishes distributed in these lakes have not been conducted in this direction.

One of the most urgent issues in modern times is the preparation of scientific bases required for the development of fisheries by determining the role of environmental factors in artificial and natural lakes of Nakhchivan Autonomous Republic.

Research methods: The samples taken from the lakes where the research was conducted were cleaned with water in the catchment area and separated according to their size. The fish was placed on its side and shaped as neatly as possible, 4% formaldehyde solution was added to cover the samples, and they were expected to harden in this way for 2-3 days to harden. The morphometric measurement of the fish was carried out with a barbell. To assess the effects of toxicants

on fish, " Vinogradov, G.A. 2000"¹ and "Metelev, V.V. 1971"² methods were used. In the assessment of quantitative and qualitative changes in the external structure and internal organs of fish, " Chugunova, N.I. 1959"³ proposed method allows to quickly determine the form and degree of pathomorphology, to conduct long-term monitoring.

Under the negative effects of the environment, the adaptive capabilities of the body weaken significantly, the development of pathologies manifests itself in the form of morphological and histopathological abnormalities in muscle tissue. Hydrochemical indicators of water were measured using the "Horiba" device.

Defending statements:

1. High man-made pressure on ecosystems of natural and artificial lakes of the autonomous republic causes significant disturbances in fish organs.

2. The dynamics and current situation of the ichthyofauna populations of the reservoirs of the autonomous republic were assessed and the role of ecological factors in their development in the reservoirs was evaluated.

3. It was determined that under the influence of anthropogenic factors (pollution of water bodies, fishing, etc.), the general structure of the fish fauna of the region changes, which is reflected in the change of the dominant species in the species composition (size-age structure, mode of reproduction and nutrition), the transfer of fish from abroad to the reservoir, the reduction of feeding and spawning areas is observed with the creation of fish-free zones; the decrease in the number of fish, bream, bream, the impoverishment of the species composition of the aquatic invertebrate fauna, as a result, led to the decrease of biological diversity in some rivers, for example -

¹ Vinogradov, G.A. Processes of ion regulation in freshwater fish and invertebrates / G.A. Vinogradov. - M.: Nauka, 2000. - 216 p.

² Metelev, V.V. Water toxicology / V. V. Metelev, A. I. Kanaev, N. G. Dzasohova, - M., - 1971. - 248 p.

³ Chugunova, N.I. Руководство по изучению воста и роста рыб / Н.И. Chugunova – Moscow: Изд-во. AN USSR, – 1959, – 162 p.

Nakhchivanchay, Gilanchay, Arpachay, etc.

4. In the conditions of changes in environmental factors, acceleration of embryo-larva development of fish and changes in the

5. size of the ovary are observed, which was accompanied by the death of individuals; Acceleration of embryo-larva development of fish and changes in the size of the ovary are observed under the conditions of changes in environmental factors, which was accompanied by the death of individuals;

6. Fish populations in the Araz reservoir are depressed under anthropogenic influence. The reproductive capacity of fish decreases, which affects their number and manifests itself in various morphological anomalies. Eating fish from high-contaminated rivers is dangerous for human health. From this point of view, it is of particular importance that fish and fish products undergo chemical and toxicological studies in the veterinary-sanitary expertise.

Scientific novelty of the research: For the first time, the modern taxonomic spectrum of the fishes distributed in the reservoirs of the Nakhchivan Autonomous Republic, the biological characteristics of the species, as well as the role of environmental factors in their development were studied. Taking into account the latest taxonomic innovations on sututars, the modern structure of the species is drawn up, and certain scientific information about them is given.

During the year, the dynamics of maturation of sexual products of fish, the time, place and conditions of spawning of fish were determined. For the first time, the dependence of the growth rate, nutrition and modern condition of the weight fish, which has a special weight in fishing, on environmental factors has been studied in detail.

For the first time, it was determined in the sututars of the autonomous republic that environmental factors, their effect on fish population and biological diversity:

- overfishing of economically important fish;
- discharge of industrial waste into sewers, significant salts of heavy metals, agricultural and household waste is aerotechnogenic pollution;

- the combination of the first two environmental factors leads to overfishing, a decrease in the average size and age of the fish caught, a reduction in the number unit and the total catch, which results in a decrease in budget revenues in this area. Changes in the number of fish in sututars in these years are associated with an increase in the share of fish caught.

The increase in illegal fishing in sututars leads to an increase in the share of unrecorded catches. In addition, the excessive discharge of water from sututars leads to the reduction of fish feeding and spawning areas, possible winter mortality and the creation of fish-free zones in lakes.

Heavy metals discharged into the river by Armenia in the Araz water basins have been found to have a negative effect on fish populations in the Nakhchivan reservoir. It was determined for the first time in the conditions of the autonomous republic that changes in temperature, hydrological and speed regimes cause late spawning of fish.

It was determined that, depending on the time and type of pollution, similar or general pathologies are observed in the body of different fish species with edema, exudates and hemorrhages. The reaction to exposure to toxicants manifests itself in the form of the occurrence of various anomalies and pathologies (nephrocalcitic, cysts, anomalies in the structure of the fins and internal skeleton, skull). Living in the zone of strong man-made influence, the number of fish of Araz reservoir, decrease in spawning potential or even complete displacement from their habitats is observed. For the first time, ways of rational management of fish resources were developed for the reservoirs of the region. Organization of monitoring of fish, assessment of the impact of economic activity on water ecosystems, preparation of ecological forecast and development possibilities and perspectives of fishing have been determined.

The theoretical and practical significance of the work: The results of the research are used in the ecological forecasting of possible changes in the ecosystems of wetlands, special works in reservoirs (explosions, construction of bridges, dredging, laying of pipes through

the bottom of lakes, extraction of sand and gravel mixtures, seismic shock waves, exploration and mining, pollution discharge into water bodies, etc.) can be used when seen. The presented practical proposals allow to prepare forecasts for fishing in sututars, to conduct fishing effectively based on the approved limit. In addition, specific proposals have been made for the efficient use of the numerous and at the same time minority species.

The results of the research are of practical importance and can be used to determine the distribution zone of the waste discharged into the environment.

It has been determined that the contamination of water bodies with heavy metals is the main reason for the observed negative effects. The recommended assessment indicators can be used in monitoring programs when assessing the quality of water ecosystems in other regions of Azerbaijan when water bodies are polluted with heavy metals.

In addition, the obtained results can be used in the teaching process of "Ecology and animal physiology", "Organism and environment" and "General ecology" courses.

Approbation and application of the work. The main provisions of the dissertation were heard and discussed at the Scientific Seminar of Nakhchivan State University, as well as at the Republican and International scientific-practical conferences listed below:

- IV International Scientific Conference dedicated to the 99th anniversary of the birth of the Great Leader Heydar Aliyev called "Actual problems of Egyptian natural and economic sciences" (Ganja, 2022);

- at the conference held in Tambov (Scientific almanac, 2021 2022);

Based on research materials, 7 articles reflecting the main content of the dissertation (three in journals included in international index databases) and 3 theses were published in the Republic and abroad.

Name of the organization where the dissertation work was performed: The research work was carried out at Nakhchivan State University.

The structure and volume of the dissertation: The total volume of the dissertation consists of 204 pages and 230481 characters. The main text consists of 169 pages, introduction (12674 characters), 7 chapters (213803 characters), conclusions (2628 characters), suggestions (1179 characters), conventional characters (197 characters), bibliography and appendices. 230 literature materials were used in the dissertation. The text part of the dissertation contains 31 pictures, 3 graphs, and 24 tables.

CHAPTER I. Literature summary

In this chapter dedicated to the study of fishes, a brief historical overview of the factors affecting the study and development of fishes of the inland water basins of Azerbaijan, including the Nakhchivan Autonomous Republic, is given.

CHAPTER II. Research materials and methods

Materials for research were collected from natural and artificial lakes located in the territory of the autonomous republic in all seasons of 2018-2021. The main objects of our study were the fish fauna of the natural and artificial lakes of the Nakhchivan Autonomous Republic of the Republic of Azerbaijan.

Nakhchivan Autonomous Republic is a region of the Republic of Azerbaijan, located between $38^{\circ}31'11''$ - $39^{\circ}47'11''$ north latitude and $44^{\circ}46'11''$ - $46^{\circ}10'11''$ east longitude. Its area is 5.5 thousand km², it is bordered by the Islamic Republic of Iran to the south and southwest, Armenia by the Zangezur and Darelayaz ranges to the north and east, and Turkey by a small land area to the west. Nakhchivan Autonomous Republic is divided into 7 administrative districts (Ordubad, Julfa, Shahbuz, Babek, Kangarli, Sharur and Sadarak).

In order to characterize the environmental factors affecting the development of fish in the studied estuaries, the hydrochemical composition of the waters and the main hydrobiological indicators (zooplankton and zoobenthos) were characterized according to both

previous publications and new information obtained by us. General biological data were recorded for all fish species collected from the area and assessments were made such as morphometric measurements, role of some pathoanatomical and abiotic factors in fish development.

Expedition work covers almost all natural and artificial lakes of the autonomous republic with fish - natural and artificial reservoirs of the Nakhchivan autonomous republic: I-Nakhchivan reservoir, II-Arpachay reservoir, III-Sirab reservoir, IV-Mazre reservoir, V-Nehram Reservoir, VI-Bilav Reservoir, VII-Barabat I, VIII-Batabat II, IX-Daste Reservoir, X-H. Aliyev Reservoir, XI- Benaniyar Reservoir, Uzunoba Reservoir (Figure).



Figure. Reservoirs under study.

In total, 8120 fish belonging to 32 species and subspecies were obtained, of which 6960 were adults of 25 species and subspecies and 1160 were juveniles of 21 species and subspecies. The morphometric characteristics of 17 species of fish belonging to the obtained species and subspecies were measured. The fish obtained during the

morphometric measurements were used for comparison with the fish samples caught daily by the fisheries. Large fish, as a rule, were measured fresh in field conditions, and their mass was determined. Most of the small fishes were fixed in 4% formalin solution and brought to the laboratory for further research. Collection and processing of material for the study of morphobiological and ecological characteristics of fishes is generally accepted in ichthyological research "Анохина, 1969⁴; Pravdin, 1966⁵; Plokhinsky, 1978⁶; Chugunova, 1959⁷" methods were implemented.

$$M = \frac{\Sigma V}{n} \quad (2.1)$$

The morphometric measurement of the fish was carried out with a barbell. The obtained fishes were processed by the variation-statistical method, and the average arithmetic figures were found by correcting the variation lines [2].

calculated using the formula

Here: M - average arithmetic number;

- plural sign;

V - indicator of each option;

n - amount of fish;

The error of the average arithmetic number;

$$m = \frac{\sigma}{n} \quad (2.2)$$

Here:

m - the error of the average arithmetic number;

⁴ Anokhina L.E. Patterns of changes in the fertility of fish. - М.: Nauka, - 1969, - 295 p.

⁵ Plokhinsky N.A. Mathematical methods in biology. М.: Изд-во. Moscow State University, 1978, 265 p.

⁶ Pravdin I.F. Guide to the study of fish. Moscow: Publishing house. food. prom-st, 1966, 376 p.

⁷ Chugunova N.I. Guide to the study of ingrowth and growth of fish. Moscow: Publishing house. AN USSR, 1959, 162 p.

n- amount of fish;

σ - mean square deviation;

Rare species were identified using frequency of occurrence. According to the frequency of occurrence, the species are numerous (occurring in more than 50% of the samples caught), average (occurring in 25-50% of the samples caught) and rare (occurring in less than 25% of the samples caught), calculated by the following formula:

$$pF = m/n \times 100\% \quad (2.3)$$

Here: m is the number of samples with individuals of a certain species, n is the total number of samples.

In the course of the research, hydrometeorological observations were made in order to study the influence of environmental factors, the properties of the water layer and bottom, temperature, level, transparency, etc. has been studied.

CHAPTER III. Faunistic analysis of fishes distributed in natural and artificial lakes of Nakhchivan Autonomous Republic

In the territory of the Nakhchivan Autonomous Republic, except for the Araz reservoir, there are 31 large and small exploited water reservoirs with a total volume of 303.52 million m³. Reservoirs are different according to their purpose, regime characteristics, parameters and natural conditions. These are the main sources of water and meet the demand for irrigation water throughout the year. Irrigation of most of the land areas is carried out through reservoirs.

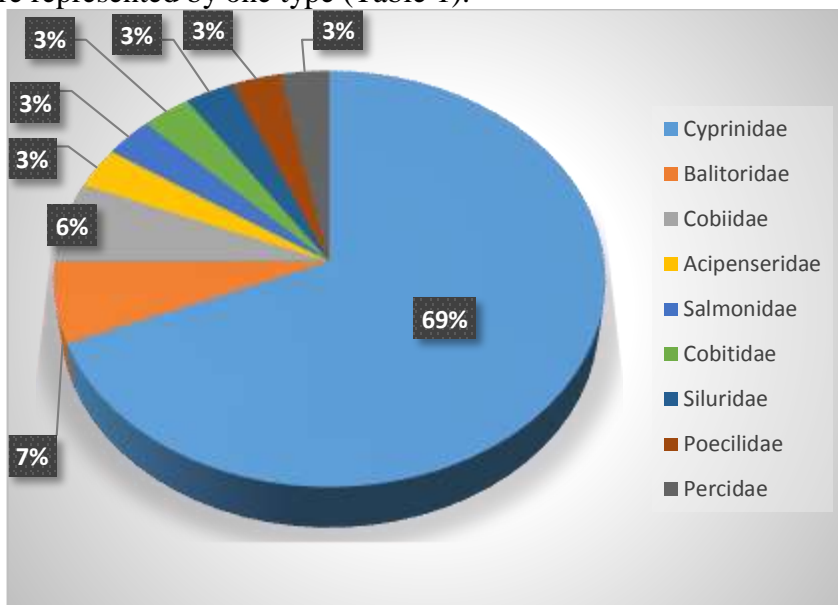
Table 1
Taxonomic evaluation of fishes common in natural and artificial lakes of Nakhchivan Autonomous Republic (with species caught in hunting)

№	Ordo	Number of Familia, per individual	Number of Genuss, per individual	Number of species, per individual	Share of species, in %	Number of subspecies, per individual
1.	<i>Acipenseriformes</i>	1	1	1	3,03	-

The continuation of Table 1

2.	<i>Salmoniformes</i>	1	1	1	3,03	-
3.	<i>Cypriniformes</i>	3	22	26	78,8	1
4.	<i>Siluriformes</i>	1	1	1	3,03	10
5.	<i>Cyprinodontiformes</i>	2	1	1	3,03	1
6.	<i>Perciformes</i>	1	2	3	9,08	2
Total:		9	28	33	100	14

During the research period, it was determined that the representatives of the Cypriniformes ordo dominated all the species in terms of the number of species in the groups that make up the ichthyofauna (26; 78.8%). The next places are respectively of the Perciformes ordo representatives (3; 9.08%). The remaining groups are represented by one type (Table 1).



Graphic 1. Distribution of species by seasons in Nakhchivan Autonomous Republic

When the species caught in the research areas were studied, the family Cyprinidae had the most species (22) with 68.75%, followed by Balitoridae with 2 species with 6.2% and Cobiidae with 2 species with 6.2%, and in the remaining families with 1 species

(Acipenseridae 3.125%, Salmonidae 3.125%%, Cobitidae 3.125%, Siluridae 3.125%, Poecilidae 3.125%, Percidae 3.125%) occupy the last places (Graphic 1).

CHAPTER V. Ichthyofauna of studied water bodies

The species composition of the ichthyofauna of water bodies was studied separately by us: Arpachay water bodies in the territory of Sharur region ($39^{\circ}39'29.88''\text{E}$, $45^{\circ}47'57.17''\text{N}$), Nakhchivan reservoir ($39^{\circ}09'13.23''\text{E}$, $45^{\circ}16'34.29''\text{N}$), Shahbuz H. Aliyev reservoir ($39^{\circ}22'41.00''\text{E}$, $45^{\circ}29'50.31''\text{N}$), Batabat I and Batabat II reservoirs located in the territory of the district ($39^{\circ}31'58.43''\text{E}$, $45^{\circ}47'20.43''$; $39^{\circ}32'22.01''\text{E}$, $45^{\circ}47'03.38''\text{N}$), Mazragöl ($39^{\circ}15'01.83''\text{E}$, $45^{\circ}31'37.21''$), Uzunoba reservoir ($39^{\circ}16'17.96''\text{E}$, $45^{\circ}25'29.58''$), located in the territory of Babek district, Sirab water reservoir ($39^{\circ}15'49.50''\text{E}$, $45^{\circ}29'22.26''$), Nehramgöl reservoir ($39^{\circ}08'15.47''\text{E}$, $45^{\circ}32'20.12''$), Benaniyar reservoir ($39^{\circ}08'53.28''\text{E}$, $45^{\circ}38'10.59''$), are sututars such as Dastagöl reservoir ($38^{\circ}53'49.29''\text{E}$, $45^{\circ}54'05.97''$) located in Ordubad region.

32 species and subspecies of ichthyofauna were found in the studied water bodies. Among them, 22 species of Cyprinidae, 2 species of Balitoridae, 2 species of Cobiidae, and 1 species in the remaining families (Acipenseridae 3.125%, Salmonidae 3.125%, Cobitidae 3.125%, Siluridae 3.125%, Poecilidae 3.125%, Percidae 3.125%) occupy the last places. The Araz reservoir is richer in species composition of ichthyofauna. Araz Reservoir takes the first place among studied reservoirs with 26 species. At the same time, the Araz reservoir plays an important role in supplying the population of the autonomous republic with fish products.

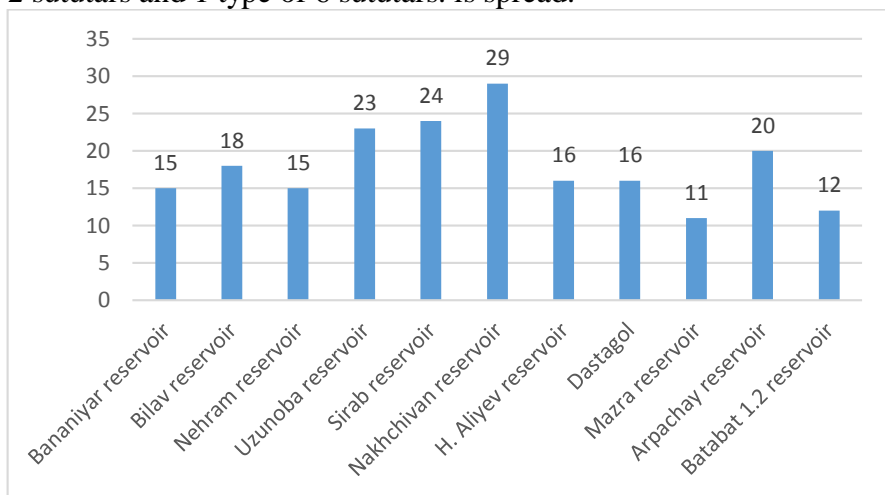
It is known that the difference in ecological factors in the sututars where ichthyofauna is found has a serious effect on the change of their general species and number composition. The highest quantity of ichthyofauna species was observed in all studied water bodies during warm and calm times of the year.

During the entire study period, the lowest value of the total number of fish in sututars was observed in the winter season, which is

related to the descent of the species to deeper water and freezing of sututars in some years.

There are 32 types of fish in the 11 reservoirs studied, of which 15 are in Benaniyar reservoir, 18 in Bilav reservoir, 15 in Nehrem reservoir, 23 in Uzunoba reservoir, 24 in Sirab reservoir, 29 in Nakhchivan reservoir, 16 in H.Aliyev reservoir, 16 in Dastagolda 16, 11 in Mazra reservoir, 20 in Arpachay reservoir, 12 in Batabat I and II lakes were recorded. Looking at the ratio of species in %, we see that the largest number of species is found in the Nakhchivan reservoir. The species distributed here constitute 91% of the total species distributed in sututars (Graph 2.).

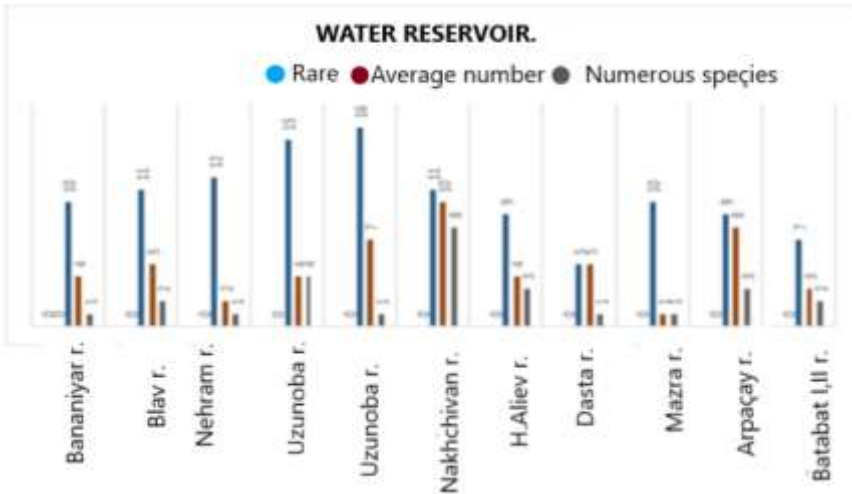
6 of the species were found in all sututar, which is 19% of the total species. Looking at the other sututars, there are 4 types of 10 sututars, 4 types of 9 sututars, 1 type of 8 sututars, 1 type of 7 sututars, 1 type of 5 sututars, 2 types of 4 sututars, 6 types of 3 sututars, 1 type of 2 sututars and 1 type of 6 sututars. is spread.



Graph 2. Number composition of species by lakes.

During the research conducted in the ponds, the highest type and quantity of fish was observed in the Nakhchivan reservoir (29 species), and the lowest quantity and species composition was observed in the pond in Dastagol area of Ordubad district (11 species).

During the years of our research, Sirab Lake had the most rare species (16 species), and Batabat I and II lakes had the least. Numerous species were found in the Nakhchivan reservoir with the most 8 species.



Graph. 3. Frequency of occurrence of species in sututars.

CHAPTER VI. The role of ecological factors in the development of fish in natural and artificial lakes of the autonomous republic

In this chapter, we will try to briefly analyze the changes that have occurred in aquatic ecosystems in recent years and their current status. Pollution accumulated in the atmosphere gradually accumulates in freshwater ecosystems and has a strong impact on living organisms. High rates of degradation of the biosphere under the influence of anthropogenic factors are one of the realities of the modern era.

In recent years, there has been a decrease in the water in the sututars of the autonomous republic, which has led to slow movement of some fish species and inconvenient distribution for feeding due to

the lowering of the water level. In spring, river overflows and floods have a strong impact on both the number and nutrition of fish. Flooding of rivers in the area usually continues until the end of May.

As a result, favorable conditions for fish feeding are created during periods of reduced flooding, the toxicogenic load on ecosystems decreases, and the food resources of sututars are fully used by fish. The extreme boundaries of the water level regime, each of which has its own characteristics, create an unfavorable situation. The ecological conditions of flood waters of rivers are characterized by the same type of hydrological regime of lakes. In recent years, there has been an inverse correlation between the productivity of the fish population and the level of pollution of the water environment, which can be distinguished by an increase in amplitude in favorable years and a several-fold decrease in unfavorable years.

During the period of our research, long-term changes were observed in the ecosystems of sututars of the autonomous republic. Thus, the main reactions of water bodies, hydrobionts, including fish to pollution have been determined. It was determined that as toxic substances accumulate in the body of the fish, specific pathological changes occur, such as: body color, decrease in muscle tissue turgor, anomalies in the shape and structure of the fins, fusion in the vertebrae, changes in the structure of the liver, spleen, and kidneys.

From our side, a number of issues related to fish ecology, water temperature, pH, salinity and relation to dissolved oxygen, etc. has been studied.

The role of abiotic environmental factors in the life of fish is very large. Thus, water temperature ensures the intensity of metabolism and is a natural stimulus that determines the beginning of migration of fish during spawning. Other physical and chemical properties of water, such as oxygen saturation and the presence of other dissolved gases in water, are also of great importance to fish.

Temperature, as a physical feature of the external and internal environment of the body, is so inseparable from all its life processes that "it is difficult to even call it a factor, because it cannot be eliminated under any experimental conditions."

Another abiotic indicator that affects the development of fish is the amount of carbon dioxide in the water. The gas regime of water is determined not only by the concentration of oxygen in the water, but also by the amount of carbon dioxide - CO₂. Gaseous carbon dioxide is present in relatively small amounts in water.

Intraspecific competition for food and cannibalism in fish occurs at the population level, in specific relationships of individuals or their sets: trophic (predator-prey, interspecies competition for food), parasitic (parasite-host), diseases (viruses, bacteria). The second main characteristic of biotic factors is that they can all be attributed to only secondary periodic or non-periodic factors.

In Nakhchivan water reservoirs, no certain regularity was observed in the seasonal changes in the amount of nitrogen in all its forms. The amount of ammonium (NH₄⁺) ions varies from 0.13 mg/l to 0.85 mg/l, and during intensive development of blue-green algae, up to 3.0 mg/l. The highest value of nitrate (NO₃⁻) ion is 4.0 mg/l. The concentration of nitrite (NO₂⁻) ion is much higher than the sanitary norm. The amount of silicon ions varies between 5.0-14.0 mg/l. In spring and summer, diatoms are consumed by algae, so its density decreases.

Table 2

Amount of some metals in water samples taken from different parts of Araz aqueduct

Control test points	Metals			
	Accepted norm mg/l			
	0,5(mq/l)	(0,1mq/l)	No information	1,0(mq/l)
	Iron	Chrome	Alminum	Copper
1.	2,00	0,50	0,19	0,50
2.	1,80	0,65	0,22	0,20
3.	2,50	0,55	0,18	0,10
4.	1,50	0,60	0,16	0,60
5.	2,00	0,65	0,18	0,20
6.	1,50	0,55	0,22	0,18

The continuation of Table 2

7.	2,00	0,70	0,25	0,11
8.	2,20	0,75	0,24	0,22
9.	2,00	0,55	0,75	0,10
10.	2,50	0,60	0,50	0,10
11.	2,80	0,95	0,95	0,40
12.	1,50	0,50	0,75	0,50
13.	1,00	0,25	0,50	0,14
14.	0,50	0,25	0,70	0,15
15.	1,00	0,75	0,82	0,86
16.	0,80	0,50	0,95	0,60
17.	1,50	0,25	0,70	0,75
18.	2,00	0,90	0,89	0,90
19.	1,00	0,40	0,75	0,40
20.	0,50	0,50	0,70	0,50
21.	0,55	0,30	0,50	0,30

CHAPTER VII. Factors affecting ichthyofauna in natural and artificial lakes in the territory of Nakhchivan Autonomous Republic

Fish species living in natural and artificial lakes of Nakhchivan Autonomous Republic are an important source of food for the local population. In recent years, according to the information of fishermen, the quantity and variety of fish in water bodies has decreased. Most of the factors that led to the decline of the fish population were caused by human influence (anthropogenic).

In terms of the diversity of fish fauna of the Nakhchivan Autonomous Republic, it is much richer than other regions of Azerbaijan. There is no doubt that the preservation of this wealth is as important as the identification of species. Since this study is the first study conducted in Azerbaijan, there is a need to add to the

recommendations the factors affecting the fish fauna of the sututars of the region and the measures necessary for their protection.

Some species of economic importance for the local population in the study area (*Acipenser stellatus kurensis*, *Rutilus (rutilus) caspicus*, *Ctenopharyngodon idella*, *Aspius aspius taeniatus*, *Luciobarbus capito*, *L. lacerta cyri*, *Blicca bjoerkna transcaucasica*, *Abramis brama orientalis*, *Cyprinus carpio*, *Hypophthalmichthys molitrix*, *Carassius auratus gibelio*, *Capoeta sevangi*, *Silurus glanis* and *Sander lucioperca* etc. red book species); they are considered to be threatened with extinction based on the density of occurrence and the number of fish caught during the study period. Although some species are of no economic importance to the local population, they are considered biological resources.

It has been observed that some taxa, which participate in the increase of species diversity and form a link in the food chain in the ecosystem, face the same threat.

7.1. Natural factors. There are many reasons for the decline of ichthyofauna resources in sututars. However, disruption of the natural balance is the main factor.

Before we start analyzing the specific data, let's make a few general notes. Adaptation of fish to living conditions in the sututars of the autonomous republic is primarily related to environmental factors that lead to maintaining the sustainability and stability of their populations. These are abiotic factors such as water temperature, oxygen regime, light regime, water pH and related biotic factors (food supply, annual rhythms of zooplankton and benthos development, etc.) in the conditions of the autonomous republic. The attitude of fish to the salinity of water occupies a special place.

The water temperature in the water bodies of the autonomous republic, which has continental climatic conditions, has a great influence on the way of life of fish. The effect of temperature varies according to the age of the fish, but it does not affect the speed of metabolic processes, the intensity of respiration and the speed of food digestion; temperature also manifests itself in the process of

development of gonads (Ramm A.E., 1986⁸). Most of the water bodies we studied are located in the lower zone of the autonomous republic, so the temperature has a great influence on the lifestyle of fish.

As we mentioned, the attitude of fish to temperature changes with age: spawning and development of young take place in the lowest temperature range. Growth of individuals occurs over a wider range of temperatures, with minimum and maximum temperatures in different seasons producing adults.

Thus, the optimal temperatures for the development of fish spawn are 0.5-5.0 - 7-14 °C. The optimum temperature for the growth of all fish in the conditions of the Autonomous Republic is between 21-24 °C. Above 24-26 °C or above 26-29 °C, growth retardation occurs, which can cause their development to stop and they die of heat shock.

Temperature has a strong influence on the course of all metabolic processes. Fish cannot live without oxygen entering the body through the blood, which directly affects the metabolism, therefore, the life activities of the body. Different fish adapt to different amounts of dissolved oxygen in the water.

And many species easily tolerate a decrease in oxygen to 3 cm³ liters. Lack of oxygen is rarely observed in the sututars of the autonomous republic, all waters are well aerated. All arctic species do not tolerate low oxygen concentration in water, and all fish from the south can withstand oxygen deficiency well.

For example, during some cold winter months, freezing events are very strong in the Araz River and other lakes, which strongly affects the way of life of fish. The direct and indirect importance of sunlight in the life of fish is great. Compared to other parts of Azerbaijan, the number of sunny days in the autonomous republic is high. Light has a good effect on the development of reproductive products. Day length is one of the most important factors in fish development.

⁸ Ramm A.E. The community degradation index: a new method for assessing the deterioration of aquatic habitats // *Wat. Res.* – 1988. – Vol.22. – № 3. – P. 293-301

7.2. Factors of environmental pollution. Environmental pollution factors; gradual decrease in the quality of sututars, a significant change in the biomass, species diversity, density and distribution of fish, reducing the degree of oxygenation of the food supply of algae, leading to a weakening of the food chain.

The main factors affecting the development of fish in sututars:

- Industrial waste
- Garbage and solid waste
- Sewage waste
- Detergents and artificial
- Agrochemicals
- Thermal pollution

Fertilizers is the main leading factor.

7.3. Other factors. In some low-monitored stutars, both professional and amateur fishermen fish to meet their fish needs regardless of the season and regardless of the abundance of fish in that stutar. Due to the mentioned factors, the fish productivity in the region is gradually decreasing, the quality of shelter, spawning and development environment suitable for fish is rapidly losing.

Untimely and excessive hunting: During periods when fishing is prohibited in sututars; during the research period, it was observed that these prohibitions were not followed very much. Although some government agencies have tried to prevent hunting, these measures have not been very successful so far. In order to prevent illegal and wild hunting, it is necessary to educate the local population, strengthen controls and make the punishments more severe. Undoubtedly, untimely and excessive fishing in inland waters creates nuisance factors depending on the food chain link. The decline of one species leads to the decline of the other species that feed on it.

Reproductive and migratory fishing: Fishing during the breeding season has been observed which reduces the number of fish and accordingly seriously affects the continuation of the generation. Spawning times of fish species that are tolerant to changes in environmental conditions are determined and reproduction opportunities are improved by ensuring sustainable fishing. According to Hossucu (2001), the reproductive periods of individuals of the same species may differ because the process of gonadal development varies

according to environmental conditions, especially temperature, from region to region. For this reason, it is important to determine the reproduction period of fish.

Introduction of new fish species into freshwater sources:

Such species are sometimes transferred to the Araz River by the Islamic Republic of Iran (3 species). In addition, further dangerous effects are hybridization, predators, competition, habitat modification, diseases and parasites.

Especially as carnivorous fishes are introduced into stagnant water bodies in accordance with the improvement of ecosystems, some fish become localized and others disappear. Fish species released into lakes threaten the population of naturally occurring fish species and subsequently lead to their extinction.

Adequate research, interpretation, effective planning and preparation should be done and followed before studies are conducted to take certain precautions and avoid undesirable outcomes. Introduction activities that would disturb the structure of the natural fish fauna should be prevented. The natural ichthyofauna of fish species common in the area is vulnerable and defenseless against such inputs.

Hydroelectric power plants: It was observed that local fishermen went to the upper reaches of the rivers to spawn before the construction of hydroelectric power stations on Nakhchivanchay, Arpachay, Gilanchay and other rivers, and only after the construction of the dam, there was a lot of difficulty. As they move upstream to breed, some species struggle with natural barriers as well as human-made barriers. Migration routes and spawning grounds are deteriorating, spawning migrations are limited and they face extinction.

Beneficial effect of hydroelectric power plants on ichthyofauna: after the establishment of lakes created on rivers, some fish species living in these rivers lead to larger populations. Such environments are more suitable for species that prefer the slow-flowing and stagnant habitats of river systems.

Illegal fishing methods: In addition to environmental factors, various fishing methods threaten the future of fish populations. Currently used illegal hunting methods:

Hunting with dynamite: When detonated in flowing water, due to the mechanical effect of severe pressure and vibration, it kills all the fish and their babies within 6-15 meters of the area of explosion, and the fish spawn at a distance of 4-6 meters is cracked.

Electric shock: When electricity is supplied directly to the water through illegal means or generators from the power grid near the river channels, the electric shock destroys all the living things in the water.

Fishing with quicklime: When quicklime is poured into slow streams, the lime reacts with the water and the dissolved oxygen in the water decreases, carbon dioxide increases, and all fish and other organisms in the water, whether large or small, die from lack of oxygen.

Hunting with poisonous plants: The leaves or seeds of many plants are used as fish poison. Laurel (*Laurus nobilis*), milkweed (*Euphorbia* sp.), wild rose (*Rhododendron* sp.) and walnut (*Juglans regia*) are examples of plants used as fish poison. Thus, not only edible fish, but also babies and other aquatic creatures perish.

In addition, fishing is not conducted with scientific knowledge that will ensure the continuation of fish populations unless forced. Both trawling and trawling alter the ecosystem at the bottom of the water, primarily by destroying fish eggs and their spawning grounds.

7.4. Content of heavy metals in organs and tissues of fish.

Fish is a bioindicator of the pollution of water bodies and is an important link in the introduction of a toxic element into the human body through the food chain. In the human diet, fish products are in the fourth place after meat, milk, bread and bakery products. Therefore, it became the basis for the study of fish fauna spread in the republic. Description of clinical and pathoanatomical signs of fish intoxication was carried out during the first hour after catching fish. The introduction of heavy metals (HM), including mercury, into water bodies binds to the water buffer system, then transforms into poorly

soluble hydroxides, carbonates, sulfides, and phosphates, and forms organometallic complexes that are adsorbed by bottom sediments and accumulated in fish. The absorption, transport, interaction with intracellular biostructures and excretion of AMs by the body is a complex active process closely related to general metabolism. Therefore, the amount of absorbed metal becomes a factor that determines the state of the organism as a whole, affecting the biochemical processes and physiological functions of aquatic organisms. As can be seen here, the fish populations there are represented by a small number of fish age groups and a minimum number of spawning generations. There is a shortening of life, a predominance of fish in young age groups, a decrease in growth rate and a decrease in average size, early maturity, starting at extremely small sizes for species or inhibition of maturation processes with growth, in growth rates, there is a long period of sexual maturity. Exposure to heavy metals in chronic subtoxic conditions alters the life cycle strategy of fish.

Since the end of 1990, a continuous decrease in the total fishing of the autonomous republic has been observed. In recent years, as a result of strong pollution by Armenia, great changes have occurred in the fauna of the reservoir. Many of the heavy metals discharged here have caused an increase in the MPC for phenol and other toxicants and have seriously affected the stocks of many fish species. These factors caused drastic changes in the severely damaged ecosystem.

All this has led to the degradation of spawning rivers and feeding areas of small fish in the near future. This contamination makes the normal course of embryogenesis and the development of the young impossible.

In order to ensure the effective conservation of a particular species, it is necessary to identify the causes that reduce the number of populations in order to minimize their impact. The anthropogenic impact on water bodies and the hydrobionts living in them can be considered by dividing them into 3 large blocks that are acceptable for our conditions.

The first block includes the following forms - physical impact, regulation of river flow, water consumption, operation of turbines, thermal pollution, cutting of riparian trees, destruction of small rivers, navigation, seismic exploration, extraction of mining and construction materials, dredging.

The second block is chemical influence - the main forms of which are the discharge of toxic substances, household and industrial waste, which often leads to eutrophication.

The third block is biological impact, which includes such forms as biological pollution, climate change, artificial reproduction, self-settlement, fishing. showed that the quality of the water masses of Araz reservoirs is in an unsatisfactory state, and this has a negative effect on fish stocks. Thus, morphological deformation was determined in some specimens caught in the Araz reservoir: fish larvae without eyes, one eye, three eyes, jaws, gill covers, three-chamber air sac, etc. fishes that.

7.5. Effect of hydro constructions on fish in Nakhchivan water basins. In the early 1970s, the infrastructure in the autonomous republic required a significant increase in energy supply capacity. There was no doubt that hydropower plants, which are very efficient and reliable sources of energy, were used for these purposes.

In 1972, the Araz River was closed for a hydroelectric dam. The construction of the dam and the regulation of the flow of the river significantly changed the hydrological, hydrochemical and hydrobiological characteristics of the reservoir and caused significant changes in its entire ecosystem. Above the dam, more than 900 m of the river has been converted into a lake-type reservoir. During the filling of the reservoir bed, the main spawning areas of many fish species remained at depths below the water and lost their importance as reproductive centers of the population of these fish species.

RESULT

The conducted research allows to draw the following conclusions from the main defended propositions of the dissertation:

1. During the research period, the ichthyofauna of the autonomous republic's lakes is represented by 32 species and subspecies belonging to 1 class, 6 groups, 9 families and 27 genera. The influence of anthropogenic factors (intensive fishing, water pollution, heavy metal pollution, drawing water from springs to villages and towns etc.) causes drastic changes in the lake ecosystems of the autonomous republic. The characteristic signs of overfishing were observed: a decrease in the average size of the fish caught, a decrease in the number of large and old age groups, and a decrease in the total weight of the fish caught [1, 2, 9, 10].

2. The study of the ecological characteristics of water reservoirs made it possible to determine the main causes of eutrophication: a decrease in the speed of water flow due to the construction of dams, the washing of mineral substances during coastal erosion, a decrease in depth, an increase in the average temperature of water, and the acceleration of the processes of destruction of organic compounds [3, 6].

3. Pollution of water by other republics with heavy metals caused the following trends in water quality: increase in its mineralization, change of ion content to increase in sulfate content due to increase in suspended particles in its content; the transparency of the water decreased, siltation occurred at the bottom, solid waste from industrial enterprises, as a result of which the structure of the fish population was changed due to the accumulation of toxic compounds [3, 8].

4. Loads (heavy metals) on the body of fish exposed to unfavorable conditions due to their toxicity caused premature death of young and old groups, inhibited growth rate and changes in metabolism, including a transition to a shorter period of residence and reproduction were observed. However, the most typical resulted in poor fish development and often prolonged spawning seasons [2, 3, 6, 8].

5. Pathologies were observed in the skeleton of some of the fish caught in reservoirs - pug-shaped nose, curvature of the ribs, formation of a tumor in the chest area and fusion of 2-3 vertebrae.

During intoxication of the body, the following abnormalities of the liver and kidneys were found: cell death and the appearance of connective tissue in their place. Disruption of the structure and activity of fish populations, the occurrence of deep pathologies and dysfunctions in their bodies lead to a decrease in the fishing potential of lakes [3, 6].

6. The studied fish species are characterized by the presence of such constant values of temperature (16, 22, 14°C), salinity (0, 4, 2‰) and pH (7.5, 8.0, 8.5), at which the highest rate of embryonic-larval development and growth rates of prelarvae are observed with minimal mortality of individuals. If the static values of the factor deviate from the optimal values, a deterioration in the considered indicators of embryonic-larval development is observed to a greater extent, the more significant such deviation was [4, 6].

PRACTICAL RECOMMENDATIONS

Use of fertilizers and pesticides:

- Recently, due to the decrease in the number of fish, a 25-33% decrease in the catch of the main commodity in the reservoirs of the autonomous republic is observed. In this regard, we suggest that the construction of fish factories for the artificial reproduction of fish, placing restrictions on the number of some tools used during fishing and hunting, and keeping accurate records of the size of the fish caught by strengthening the control of hunting activities;

- Since pesticides are toxic to wildlife as well as fish, care must be taken to prevent them from entering surface waters. Cleaning equipment in water sources should be avoided after treatment is completed. Places where all kinds of streams, sewage and sewage water, solid wastes are poured into water should be identified, infrastructures should be prepared to prevent their spillage into rivers and lakes;

- Caught fish can be used after sanitary assessment with determination of biochemical, parasitological and organoleptic

parameters. The main criteria are not only the consistency, smell, the amount of mucus on the surface and in the gills, fatness of the fish, but also *Ligula intestinalis*, *Myxobolus* spp. and *chthyocotylurus* spp., *Paracoenogonimus ovatus*, *Ergasilus sieboldi*, *Tracheliastes maculatus*, the energy value of products decreases by 23-26%.

LIST OF PUBLICATIONS ON DISSERTATION

1. Karimova, Sh.I. Ichthyofauna of Nakhchivan Autonomous Republic and conditions of its study // – Science Almanac, – 2021. N 12-2(86), – p. 35-41.
2. Karimova S.I. Ichthyofauna of Nakhchivan Autonomous Republic and its state of study // – Nakhchivan: NDU,– 2021. No. 3 (112), – p. 83-90
3. Karimova, Sh.I. Some fish species of fishery importance in Nakhchivan part of Aras reservoir // – Bulletin of Science and Practice, – 2022. T. 8. №4, – p. 72-81.
4. Karimova, Sh.I. Assessment of fish fauna of natural and artificial water bodies in Nakhchivan and the environmental factors that have impact over them // – Bulletin of Science and Practice– 2022. – vol. 8, №6, – p.-66-70.
5. Karimova, Sh.I. Acipensor Stellatus, Rutilus (Rutilus) Caspicus, Leuciscus Cephalus Orientalis of the Fauna of the Nakhchivan Autonomous Republic Faunistic Analysis of Fishes // – International Journal of Zoology and Animal Biology, –, – 2022. vol. 5, Issue 4, – p. 1-4.
6. Karimova, S.I. Evaluation of the fish fauna of some large, natural and artificial lakes of the Nakhchivan Autonomous Republic and the environmental factors affecting them // – Nakhchivan: NDU, No. 3 (116), –2022, – p. 27-31
7. Karimova, S.I. Morphometric evaluation of the carp (*Cyprinus carpio* Linnaeus, 1758) found in the Araz reservoir // Current problems of Egyptian natural and economic sciences. – Ganja, – 06-07 Mays – 2022, – p. 220-224

8. Karimova, Sh.I. The influence of heavy metals on the development of fish in lake ecosystems // 1st Republican scientific conference on "Modern view of Nakhchivan Ecosystem" - NSU, September 22, - 2023, - p.84-87
9. Karimova, S.I. Taxonomic spectrum of ichthyofauna of Nakhchivan Autonomous Republic // – Nakhchivan, – 2022. No. 4, – p. 222-227
10. Karimova, Sh.I. "Certain fish species of fishery importance in the part of Aras reservoir within Nakhchivan Autonomous Republic" // – India International Journal of Entomology Research, – 2022. No 169, t. 11, – p 1-5.



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